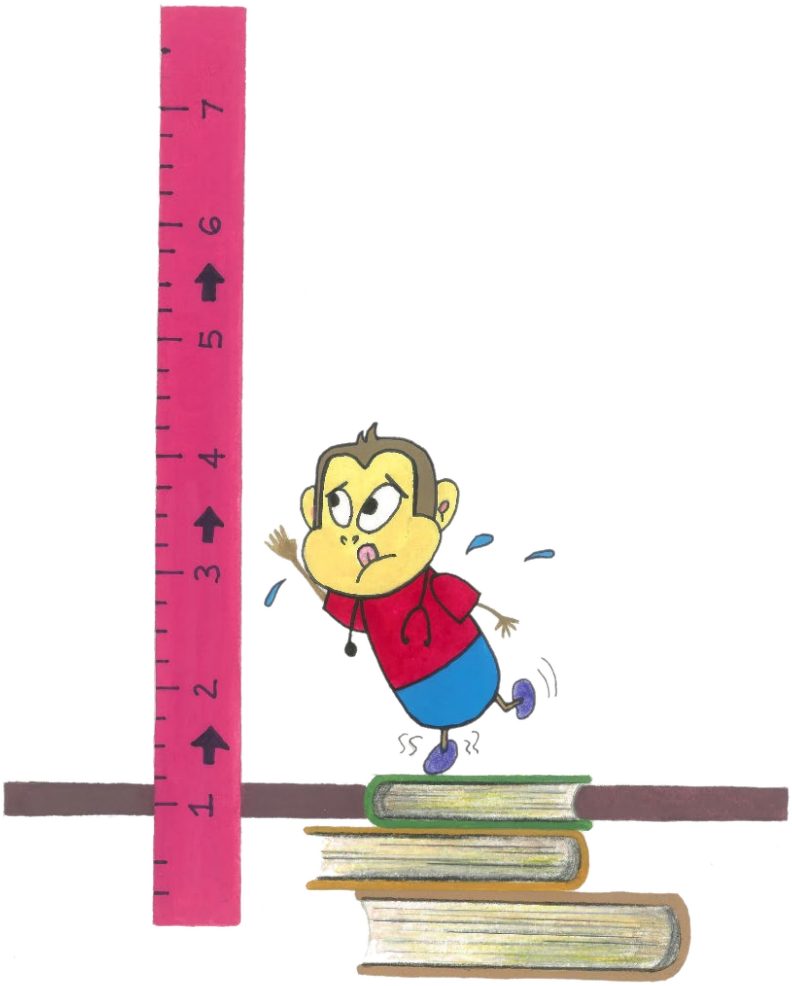
Chapter 2:
DISORDERS OF DEVELOPMENT

Student Authors: Lehlohonolo Ntlatlapo and Daniella Carvalheiro
Specialist Advisor: Dr Mark Richards



This chapter covers the following topics:

- Developmental delay (delayed milestones)
- Intellectual developmental disorder (IDD)
- Autism spectrum disorder (ASD)
- Cerebral palsy (CP)

DEVELOPMENTAL DELAY (DELAYED MILESTONES)

Definition

It is a delay in developing cognitive, language and/or motor skills. This delay is an indicator of an underlying condition(s), meaning that it is a symptom rather than a diagnosis.

Each child reaches developmental milestones at his/her own pace, therefore temporary delays may occur in some children, but should not be alarming. Multiple or ongoing developmental delays are a cause for concern, as they may lead to problems later in life. Early detection of developmental delays may reduce or prevent long-term disability, through early intervention.

Pathogenesis

The pathogenesis of developmental delays is not always clear, but associations include (not in order of frequency):

- Genetic disorders e.g. Down syndrome, Fragile X syndrome
- Failure to thrive (any cause)
- Foetal alcohol syndrome
- Cerebral palsy
- Autism
- Landau-Kleffner syndrome
- Myopathies
- Intellectual disability
- Hydrocephalus
- Cystic fibrosis

Clinical Features

Developmental milestones are assessed using a Developmental Milestone Chart.

Table 2.1: Developmental Milestones by Age

AGE	FINE MOTOR	LANGUAGE	GROSS MOTOR	PSYCHOSOCIAL	WARNING SIGNS
6 weeks	Fixes and follows object through 90º.	Gurgles. Startles to loud sounds.	Head-lag is still present.	Smiles responsively.	
14 weeks / 3 months	Fixes and follows through 180º. Pulls at clothes. Hands loosely open.	Coos and chuckles. Quiets to familiar sounds. Turns head to sound.	Little/no head lag on pull-to-sit. Lifts head when prone (neck holding). Moro reflex is disappearing.	Smiles at primary caregiver (social smile at 2 months). Upset when caregiver leaves.	No visual fixation. No response to sound. Absent vocalisation. Floppy (++ head lag). Asymmetry of tone or movement. No social smile at 2 months.
6 months	Voluntarily reaches and grasps. Transfers objects between hands. Mouths objects.	Laughs. Vowel-type babbling (monosyllables). Turns to mother's voice across room.	Braces on pull-to-sit. Sits in tripod fashion. Lifts chest and shoulders when prone. Rolls over in both directions.	Takes everything to mouth. Recognises strangers.	Fails to track people or objects. No response/turn to sound or voice. No vocalising. No steady head control. Does not roll over. No affection for caregiver.
9 months	Points. Immature pincer grasp. Holds a small	Deliberate vocalisation. Babbles. Imitates sounds. Says	Sits without Support. Crawls. Pulls to stand.	Waves "bye bye". Has stranger anxiety.	Squints. Persistent primitive reflexes. No hand preference.

	object in each hand.	disyllabic words. Understands “bye” and “no”.	Stands with support.		Monotonous vocalisation. Unable to sit. Does not respond to own name and doesn’t play any games involving back-and-forth.
12 months	Pincer grasp matures.	Says 1-2 words with meaning. Responds to simple requests.	Creeps well. Walks but falls. Stands without support.	Comes when called. Plays simple ball games. Claps. Co-operates with dressing.	Immature pincer grasp. Does not search for things that are hidden or points. Does not say single words. Cannot stand when supported and does not crawl. Does not wave.
15 months	Imitates scribbling. Builds two-block towers.		Walks alone. Creeps upstairs.	Has jargon.	
18 months	Holds pen (palmar grasp) and scribbles. Builds 3-block towers.	Has 8-10-word vocabulary. Understands simple commands without hand gestures).	Walks and runs well (arms down). Throws a ball. Climbs onto an adult chair.	Copies parents in tasks. Handles spoon and cup. Indicates wet nappy.	No pincer grasp. Mouthing. Not walking. Does not notice or mind when a caregiver leaves or returns.
24 months	Spoon-feeds well. Imitates vertical line. Hand	Speaks in short phrases (2-3-word sentences). Identifies 5 body parts	Jumps. Walks up and down stairs, placing both feet on each	Asks for food, drink, and toilet. Spoon-feeds without spilling.	No single words. Cannot walk steadily.

	preferenc e is usually present. Builds 6-block towers.	(points). Obeys e.g. “Put the pen on the table.”	step. Kicks ball.		
36 months	Copies a circle. Builds 6-block towers. Builds bridge from blocks. Matches colours.	Able to talk in full sentences (3-4 words). Asks questions. Knows full name, age, and gender. Points to 5 colours. Rote counts to 3.	Can pedal a tricycle. Uses alternate feet when going upstairs. Walks on tiptoe. Throws and kicks ball.	Shares toys. Is toilet trained. Dresses with supervision. Uses knife and fork.	Only uses single words. Exhibits echolalia. Unable to understand and follow simple commands. No eye contact.
48 months	Copies a cross and square. Draws man with 3 parts.	Knows full name, address, age and colours. Can sing a song or say a poem. Tells stories. Counts to 10. Understands the past tense.	Climbs steps 1 foot per step (no handrail). Hops on preferred foot.	Washes and dries hands. Involved in make-believe play. Plays cooperatively. Goes to the toilet alone. Brushes teeth.	Speech is difficult to understand (to non-family). Difficulty with scribbling; Cannot jump in place. Does not play well with other children.
5-6 years	Copies a triangle and square. Draws a man with six parts. Can fasten and unfasten buttons.	Understands concepts – cold, tired, hungry (Ask “What should a person do if s/he is cold?”). Asks for the meaning of words.	Walks easily in a narrow line (heel to-toe). Hops on each foot. Bounces a ball.	Chooses his/her own friends. Uses a knife and fork with confidence. Helps with household tasks, dressing and undressing.	Has poor pencil grip. Is clumsy. Has poor posture. Fails to meet milestones.

				Acts out role play.	

INTELLECTUAL DEVELOPMENTAL DISORDER (IDD)

Definition

IDD is, according to the DSM-V, “a disorder with onset during the developmental period that includes both intellectual and adaptive functioning deficits in conceptual, social, and practical domains”.

Table 2.2: DSM-V Criteria for Diagnosing IDD

DSM-V Diagnostic Criteria (Intellectual Developmental Disorder)
A. Deficits in intellectual functions (e.g. reasoning, planning, problem-solving, abstract thinking, academic learning and learning from experience, judgment, and practical understanding) confirmed by clinical assessment and intelligence testing.
B. Deficits in adaptive functioning that lead to failure to meet developmental and sociocultural standards for independence and social responsibility. Without support, the adaptive deficits limit functioning in the activities of daily life (e.g. communication, independent living, social participation) across multiple contexts (e.g. home, school, work, recreation).
C. Onset of A & B is during the developmental period.

Intellectual disability can be classified as mild, moderate or severe on the basis of adaptive functioning scores. IQ measures are not used to classify severity as they are less valid in the lower end of the IQ range and it is the adaptive functioning that determines the level of support required, rather than the IQ score.

Pathogenesis

Often the cause is unknown. However, foetal alcohol syndrome (FAS) is the most common preventable cause of IDD. Other causes include:

- Genetic disorders e.g. Down’s syndrome
- CNS malformations of unknown aetiology
- External prenatal factors e.g. exposure to medication, alcohol, drugs or toxins, maternal illness (diabetes, hypothyroidism, hypertension, malnutrition), gestational disorders

- Perinatal factors e.g. neonatal septicaemia, pneumonia, meningitis, encephalitis, congenital infections, problems at delivery (asphyxia, intracranial haemorrhage or birth injury) or other neonatal complications (respiratory distress, hyperbilirubinaemia or hypoglycaemia)
- Postnatal factors (occurring in the first year of life) e.g. CNS infections, vascular accidents, tumours, head injury, hypoxic brain injury, exposure to toxic agents or psychosocial deprivation
- Other disorders of unknown aetiology e.g. cerebral palsy, epilepsy, autism spectrum disorders

Management

One should offer genetic counselling to families with a history of IDD and certain genetic disorders that increase the risk for IDD. The patient and the family should be provided with psychosocial support, in the form of emotional support and counselling, and social worker assistance with application for social grants. The parents should also be provided with information on the need to enrol the child in a special school.

The multidisciplinary team (doctors, occupational therapist, physiotherapist, speech and language pathologist, audiologist, social worker and counsellor) should be involved in the management of these children. The medical team must manage any medical problems that might be present or which are associated with the underlying condition. The patient receives routine paediatric health care.

AUTISM SPECTRUM DISORDER (ASD)

Definition

ASD is a group of lifelong neurodevelopmental disorders characterised by their effect on social and communication skills, as well as by a restricted, stereotyped, repetitive repertoire of interests, behaviours and activities.

Assessment

A comprehensive evaluation of the child must be done, preferably by a multidisciplinary team. Ancillary testing may be required to exclude mimicking conditions.

History and Examination

One must take a thorough history from caregivers and collaterals e.g. teachers. The child should be carefully observed, focusing on the developmental and behavioural features specified in the DSM-5, medical history and family history. The assessment should include the child's strengths, needs, skills and impairments. Gather collateral information from teachers.

A thorough physical examination should be conducted. Findings from the physical examination may help diagnose comorbid conditions or identify symptoms of disorders that are associated with ASD e.g. tuberous sclerosis complex (see related image here).

Investigations

Screening tools, such as the Childhood Autism Spectrum Test (CAST), may be used to screen for ASD. The child should then be referred to specialised services (e.g. paediatric neurodevelopmental clinic if <7 years or child psychiatry) for multidisciplinary assessments, and standardised ASD assessment with instruments such as the Autism Diagnostic Observation Schedule (ADOS) and Autism Diagnostic Interview – Revised (ADI-R).

Diagnosis

This condition is diagnosed at an early age due to speech and language delays, and social communication developmental delays, and stereotyped behaviours. There are still some people who are only diagnosed as adolescents because these signs were not obvious in childhood.

Table 2.3: DSM-V Criteria for Diagnosing ASD

DSM-V Diagnostic Criteria for Autism Spectrum Disorder
A. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by the following, currently or by history (examples are illustrative, not exhaustive): B. Deficits in social-emotional reciprocity e.g. abnormal social approach, failure of normal back-and-forth conversation, reduced sharing of interests, emotions, or affect, failure to initiate or respond to social interactions. C. Deficits in non-verbal communicative behaviours used for social interaction e.g. poorly integrated verbal and non-verbal communication, abnormalities in eye

contact and body language, deficits in understanding and use of gestures, total lack of facial expressions and non-verbal communication. D. Deficits in developing, maintaining and understanding relationships e.g. difficulty adjusting behaviour to suit various social contexts, difficulty sharing imaginative play or making friends, disinterest in peers.
E. Restricted, repetitive patterns of behaviour, interests, or activities, as manifested by at least two of the following, currently or on history (examples are illustrative, not exhaustive): F. Stereotyped or repetitive motor movements, use of objects, or speech e.g. simple motor stereotypies, lining up toys, flipping objects, rocking, spinning, echolalia, idiosyncratic phrases. G. Insistence on sameness, inflexible adherence to routines, or ritualised patterns or verbal nonverbal behaviour e.g. extreme distress at small changes, difficulty with transitions, rigid thinking patterns, greeting rituals, need to take the same route or eat the same food every day. H. Highly restricted, fixated interests that are abnormal in intensity or focus e.g. strong attachment to or preoccupation with unusual objects, excessively circumscribed or perseverative interest. I. Hyper- or hyporeactivity to sensory input or unusual interests in sensory aspects of the environment e.g. apparent indifference to pain/temperature, adverse response to specific sounds or textures, excessive smelling or touching of objects, visual fascination with lights or movement.
J. Symptoms must be present in the early developmental period, but may not become fully manifested until social demands exceed limited capacities or may be masked by learned strategies in later life.
K. Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning.
L. These disturbances are not better explained by intellectual disability (intellectual developmental disorder) or global developmental delay. Intellectual disability and autism spectrum disorder frequently co-occur. To make comorbid diagnoses of autism spectrum disorder and intellectual disability, social communication should be below what is expected for that child's general developmental level.

Table 2.4: Levels of Severity of ASD

Severity level	Social communication	Restricted, repetitive behaviours
Level 1 "Requiring support"	Without supports in place, deficits in social communication cause noticeable impairments. Difficulty initiating social interactions, and clear examples of atypical or unsuccessful response to	Inflexibility of behaviour causes significant interference with functioning in one or more contexts. Difficulty

	social overtures of others. May appear to have decreased interest in social interactions. For example, a person who is able to speak in full sentences and engages in communication but whose to- and-fro conversation with others fails, and whose attempts to make friends are odd and typically unsuccessful.	switching between activities. Problems of organisation and planning hamper independence.
Level 2 "Requiring substantial support"	Marked deficits in verbal and non-verbal social communication skills. Social impairments are apparent even with supports in place. Limited initiation of social interactions and reduced or abnormal responses to social overtures from others. For example, a person who uses simple sentences, whose interaction is limited to narrow special interests and has markedly odd non-verbal communication.	Inflexibility of behaviour, difficulty coping with change, or other restricted/repetitive behaviours appear frequently enough to be obvious to the casual observer and interfere with functioning in a variety of contexts. Distress and/or difficulty changing focus or action.
Level 3 "Requiring very substantial support"	Severe deficits in verbal and non-verbal social communication skills cause severe impairments in functioning, very limited initiation of social interactions, and minimal response to social overtures from others. For example, a person with few words of intelligible speech who rarely initiates interaction and, when he or she does, makes unusual approaches to meet needs only and only responds to very direct social approaches	Inflexibility of behaviour, extreme difficulty coping with change, or other restricted/repetitive behaviours markedly interfere with functioning in all spheres. Great distress/difficulty changing focus or action.

Comorbidity

Common comorbid psychiatric conditions include:

- ADHD
- Developmental coordination disorder
- Anxiety
- Obsessive-compulsive disorder (OCD)
- Depression

See related image here.

Management

The goals of management for the child with ASD are to:

- Improve social functioning and play skills
- Improve functional and spontaneous communication
- Improve adaptive skills
- Decrease non-functional or negative behaviours
- Promote academic functioning
- Improve cognition

The parents and medical team must adapt the child's environment, activities and routines to suit him/her. The parents and multidisciplinary team must also liaise with educational services regarding appropriate support and school placement. If the child is at a mainstream school, s/he may need a facilitator.

The multidisciplinary team should consist of:

- Medical doctors (to provide the patient with routine paediatric health care):
  - Pharmacological management can be helpful, especially if there are comorbid conditions.
  - Risperidone can be given as short-term treatment of significant aggression and melatonin can be given to help with sleep disturbance.
- Social worker and counsellor
- School psychologist
- Occupational therapist (to improve functioning)
- Speech and language pathologist (to assist with communication difficulties)
- Social worker (to assist with the social grant application)

The patient and family should be provided with psychosocial and emotional support, and counselling. HelpGuide.org has information and action plans for parents including a guide to Helping your Child With Autism Thrive. See related image here.

CEREBRAL PALSY (CP)

Definition

CP is a group of disorders characterized by permanent, non-progressive injury to the developing brain, which manifest as impairments of movement and posture and limit activity. A graphic definition of CP is available here.

Pathophysiology

CP is attributed to non-progressive disturbances or a static injury to the developing brain that occurs in the developing foetus (i.e. in utero), infant or toddler (up to 2 years of age). Brain asphyxia was originally implicated as the main cause of CP but multiple ante-, peri-, and postnatal factors are now implicated in the pathogenesis. Environmental factors, which might interact with genetic vulnerability, have also been implicated.

Multiple biochemical factors resulting in a hypoxic-ischemic state, cell death and inflammation are thought to play a role. These factors include:

- Excessive production of proinflammatory cytokines
- Oxidative stress
- Maternal growth factor deprivation
- Extracellular matrix modifications
- Excessive release of glutamate, triggering the excitotoxic cascade

Table 2.5: Classification of the Causes of CP According to the Time of Insult

Prenatal	Perinatal	Postnatal
• Maternal/ foetoplacental disease e.g. pre-eclampsia • Foetal malformations e.g. cerebral malformations, hydrocephalus • Genetic syndromes • Chromosomal abnormalities • Intrauterine infections e.g. CMV, HIV, rubella • Intrauterine vascular events • Teratogens	• Hypoxic-ischaemic encephalopathy • Labour/delivery complications • Intraventricular haemorrhages • Infection/sepsis • Biochemical derangements e.g. bilirubin encephalopathy	• Trauma to the developing brain e.g. traumatic brain injury • Meningitis/ encephalitis (incl. TB meningitis) • Vascular disorders e.g. stroke • Toxins • Idiopathic

Clinical Features

The core feature of CP is motor impairment. It is important to remember that the clinical motor manifestations of CP are dynamic and the clinical picture will change depending on:

- Stage of development of the brain at which the insult occurred
- Extent and severity of the insult to the developing brain
- Stage of development of the brain at the time of insult

Therefore, over time, different types of CP may emerge, only to be replaced when other areas of the brain reach a stage of maturation and exert their influence on a damaged, but developing, brain.

However, generally, the clinical features of CP include:

- Inspection:
    - Scissoring of legs
    - Equinus deformity of the feet (leading toe walking)
    - Muscle wasting
- Tone:
    - Hypertonic fisting of the hand with the thumb adducted across palm
    - Truncal hypotonia with head lag, neck retraction and opisthotonus (due to increased tone)
- Reflexes:
    - Brisk deep tendon reflexes
    - Ankle clonus
    - Inappropriately positive Babinski
- Power (reduced)

Table 2.6 serves as a guide on how to classify motor involvement in the child with CP. Generally, the higher the level, the more severe the CP. However, all children are different.

Table 2.6: Gross Motor Functional Classification System of CP

AGE (years)	**LEVEL**				
	1	**2**	**3**	**4**	**5**
0-2	Learns to sit, uses	Can sit but with adult	Can roll and creep	Can roll. Can only sit	Voluntary control of

	both hands to play with objects. Can crawl and pull-to-sit on his/her own. Walks by 18 months.	assistance or when using his/her hands for support. May begin to crawl or “creep” on his/her belly.	forward while on his/her stomach. Needs lower back support when trying to sit.	with trunk assistance.	movements is impaired. No head and trunk control without support. Needs help with rolling.
2-4	Sits without assistance. May start to stand on his/her own. Walking starts being preferred over crawling.	Can sit with assistance. Reciprocal patterns are used when crawling. Walks with assistive devices or holding onto other objects.	Can sit unsupported but typically in a “rotated hips and knees” position. Can crawl (crawling is the preferred mode of moving around).	Can sit but uses hands & arms for support. May need adaptive equipment for sitting and standing. Crawling, creeping and/or rolling preferred.	All motor function areas are still limited, therefore, still needs assistance.
4-6	Can sit in chairs and get up from chairs without help. Walks freely and begins to run and jump.	Can sit on chairs without help. Assistance is needed to move from standing to the floor. Can walk short distances without support but cannot	Can sit upright on a chair but needs trunk support when using his/her hands. Can get off of chairs with assistance. Uses assistive devices to walk.	Can sit on chairs with trunk support and can move from chairs with support. Can walk short distances but may have problems turning and keeping	Can sit on chairs but needs adaptive equipment to hold him/herself in place. Needs to be transported even for daily activities.

		skip, run, or jump.		his/her balance.	
6-12	Can run, walk, jump and climb stairs on his/her own. *Note*: Balance and coordination may still be lacking.	Can walk with little to no assistance but needs help when walking in crowds or on inclined surfaces. Needs rails for climbing stairs, and shows minimal abilities for running, jumping and skipping.	Can walk with assistive devices. Uses handrails for stairs. Needs to be carried or use wheelchairs when travelling long distances or over uneven/ inclined surfaces.	Can maintain same mobility from age 6. May rely on wheelchairs and walking aids.	May be able to mobilise on his/her own with an electronic wheelchair, but still has limited mobility. Still cannot support the trunk and body. Expansive adaptation equipment used in some instances.

Types of CP

CP may be classified according to the part of the brain that is damaged.

Spastic CP

This is the most common type of cerebral palsy as the injury affects the cerebral motor cortex. The muscles feel stiff and their movements may look jerky. Spasticity is a form of hypertonia, which can make movement difficult or even impossible. Subtypes include:

- Monoplegia
- Hemiplegia
- Diplegia (legs are affected more than arms)
- Quadriplegia

Note: Paraplegia is not a form of CP because it is the result of a spinal injury and CP is the result of damage to the developing brain. A definition of CP is also provided here.

Extrapyramidal CP

These patients have variable movements that are involuntary and which are especially noticeable when attempting to move. Subtypes include:

- Dystonic (commonly caused by bilirubin encephalopathy)
- Athetoid
- Ataxic*
- Hypotonic*

The first two subtypes (also called dyskinetic CP, see visual here) are caused by damage to the basal ganglia and the latter are caused by damage to the cerebellum.

Note: Hypotonic and ataxic CP: these two rarely occur alone. When hypotonia does occur without ataxia (but with intellectual disability), this is NOT classified/ defined as CP.

Mixed CP

These patients present with a combination of the symptoms of spastic CP and extrapyramidal CP (dyskinetic and ataxic-hypotonic CP).

Associated Disorders and Complications

The motor disorders of CP are often accompanied by:

- Disturbances of sensation, perception, cognition, communication, and behaviour
- Epilepsy
- Secondary musculoskeletal problems
- Feeding difficulties e.g. GORD.

See related image here.

Investigations

They are guided by history and examination and may include:

- Neuroimaging (CT scan)
- Specific genetic or diagnostic tests
- Metabolic tests (amino acids, organic acids, thyroid function tests)
- X-rays (hips, spine)
- Electrophysiological studies (EEG, VER, ERG, BAER)

Management

The treating team must educate the family and child about the prognosis for people with CP and establish treatment priorities. Management may include:

- Identifying special needs – almost all individuals with CP have at least one other developmental disability
- Routine paediatric health care:
    - Regular nutritional assessment
    - Anthropometric assessment (on growth charts for CP children)
    - Regular follow-up
    - Adequate management of other health problems (the child must be sent to an audiologist for hearing screening)
- Supportive physical therapy:
    - Physiotherapy and occupational therapy:
        - The aim is to reduce muscle tone and improve positioning, posture and functionality through targeted exercises and with the help of assistive devices
        - These devices include walkers, splints, standing frames and wheelchairs (see image here)
    - Speech and language therapy:
        - The child and parents will be taught about oral coordination, how to manage drooling, using alternative/augmented communication and how to feed the child who has had a gastrostomy
- Medical interventions and orthopaedic surgery:
    - Muscle relaxants e.g. benzodiazepines (diazepam), baclofen

    - Botulinum A toxin injections (Botox® is an effective adjuvant to other therapies as it increases stretch in relaxed muscles and reduces dynamic spastic deformity)
    - Contracture release (improves mobility)
    - Hip subluxation/dislocation reduction or prevention
    - Reconstructive surgery
    - Neurosurgery – rhizotomy (for selected cases)
- Psychosocial support:
    - Social grant assistance (in South Africa, the care dependency grant)
    - Schooling intervention (especially for less severe forms)
    - Counselling for the parents and family

Prevention

CP may be prevented with good antenatal care, avoidance of prematurity, avoidance of IUGR, prevention of birth asphyxia with good perinatal care, good obstetrics and post-natal care. One may also decrease the incidence of CP in 2-year-old children if:

- Full-term neonates with moderate neonatal encephalopathy are treated with therapeutic hypothermia
- Magnesium sulphate administration to mothers in preterm labour

The complications of CP may be prevented with early diagnosis and intervention.